ECONOMICS IN ENGINEERING

by

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SUMMARY

The application of economics in engineering is so important that too much emphasis cannot be placed upon it. Two examples are given. One treats with transmission of electrical power; the other treats with the economy of a rectifying column. The examples are of the most elementary character, but nevertheless they serve to indicate how economics affects engineering. Although only two fields, i,e. electrical and chemical, are touched because of the necessary brevity of the thesis, it is not to be assumed that other types of engineering are devoid of applications of economics.

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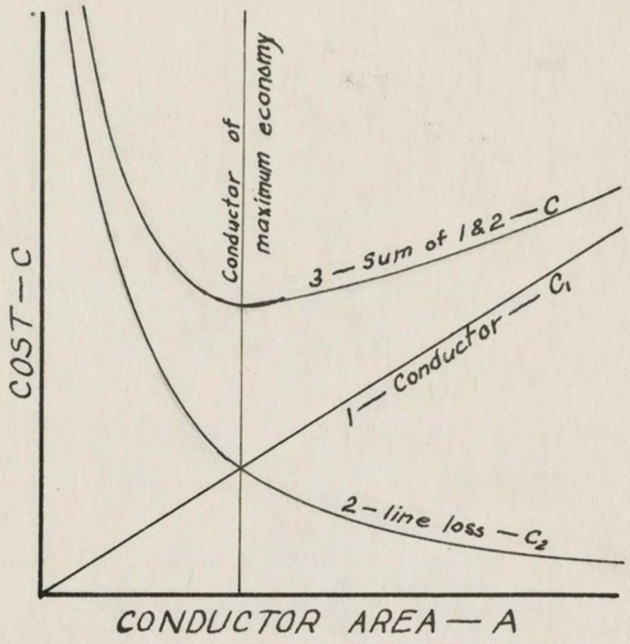
An understanding of the fundamental principles of economics and a knowledge of practical economics constitute an extremely important division of an engineer's information. Quite frequently the undergraduate engineer is confronted with the necessity of making allowances in his problems for economic factors. The same is even more true for engineers who are actively engaged in the field. From an engineer's viewpoint the most efficient method is likewise the most economic method, and that is why he must be able to employ economics in the solution of his problems. Two examples in the fields of electrical and chemical engineering will serve to indicate the importance of economics in engineering.

The transmission and distribution of electric power is one of the most complicated problems with which an electrical engineer must cope. He finds it necessary to balance various items——such as initial cost, maintenance, and depreciation——against the power loss in the transmission line in such a manner as to arrive at a minimum total cost. The size of wire which satisfies this condition is the correct size to use. A simple example will be presented for

purposes of illustration.

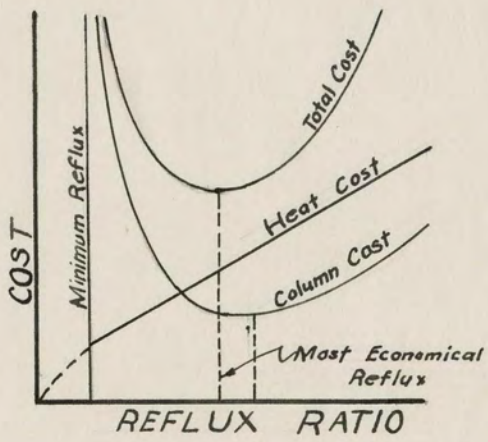
The cost of a conductor of a given material and of fixed length is proportional to its size. The annual outlay chargeable to conductors for taxes, interest, and depreciation is therefore directly proportional to the area of the conductor. Mathematically this may be expressed as $C_1=k_1A$ wherein C_1 represents the cost, k_1 is a constant, and A represents the area of the conductor. The constant k_1 contains all the economic factors. When a given amount of power is transmitted over a given distance, however, the amount of heat energy lost in the conductors during any operating period is inversely proportional to the conductor area. The money value of this lost energy may be represented by $C_2=\frac{k_2}{A}$ wherein k_2 is another constant. The total cost is therefore $C=C_1+C_2=k_1A+\frac{k_2}{A}$. Application of the calculus easily shows that C is a minimum when $C_1=C_2$ or when $k_1A=\frac{k_2}{A}$. The area of the conductor is, therefore, $A=\sqrt{\frac{k_2}{k_1}}$. The evaluation of the constant k_2 is relatively simple matter based upon known physical laws. The evaluation of the constant k_1, on the other hand, is difficult because it involves the aforementioned economic factors, which are not subject to rigid physical laws. A graphical analysis of the problem would appear as follows.



The relation just derived is important enough to be known as Kelvin's law, Which may be stated as follows: The most economical area of conductor is that for which the annual cost of energy wasted is equal to the interest on that portion of the capital outlay which can be considered proportional to the weight of conductor used.[1] It is quite evident, therefore, that economics has an important role in electrical engineering.

1. Loew, Direct and Alternating Currents, p. 289

A very similar example can be cited in the field of chemical engineering for the case of a rectifying or fractionating column. With a reflux just greater than the minimum, the diameter of the column is small but the number of plates is very large. As the reflux ratio is increased slowly, the diameter of the column increases slowly but the number of plates decreases rapidly, thereby decreasing the cost of the column. As the reflux ratio continues to increase, the diameter of the column increases proportionally, but the number of plates is not greatly decreased, and hence the cost of the column increases again. The cost of heat for the still increases in proportion to the reflux ratio. The sum of column and heat costs is a minimum for most economical operation. The graphical picture is as follows.[2]



2. Badger and McCabe, Elements of Chemical Engineering p. 365

Here again, since the column costs include such items as maintenance and depreciation, it is evident that economics plays an important part.

These examples are but two from a myriad of such instances in which economics is involved. The two which were chosen are relatively simple; other problems are quite complex.

Application of economics is so necessary throughout all engineering that too much emphasis cannot be placed upon it. Although trained in the exact sciences, the average engineering graduate plunges into the world of industry to find that economic factors combined with technical factors determine proceedure and success in carrying out any plan. Engineers, in contributing so liberally to the material advance of civilization through invention and mechanization, are faced with meeting those problems of an economic nature which this advance has brought about.[3]

3. Lester, Applied Economics for Engineers, p. 3

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